

by Prof. Forel in the remarkable natural grotto of the Arolla glacier, of which he has given so fascinating a description in the *Archives des Sciences physiques et naturelles*, Genève, 1887, xvii., p. 498. The delineation of the etched figures by rime was observed by him in the month of July in a remote and secluded chamber nearly 250 metres from the entrance of the grotto. In artificial grottos like that of the Morteratsch glacier, in which the air circulates freely, the hoar-frost disappears very quickly with the end of winter.

The Grain of Lake Ice.

It is not glacier ice alone which suffers disintegration when exposed to a powerful sun. Lake ice behaves in a similar way. Beautiful examples of this can be seen in Alpine seas every winter. During the harvesting of the ice from the lake, the blocks often lie for a day or more before they are carted away to the ice-houses. Occasionally some of them get overlooked and remain for many days exposed to the powerful sun of February, while maintaining the low temperature of the air usual in that month. No melting takes place, but after even a few hours' exposure to the sun the block shows the figure of its grain in development. It is being etched by the sun's radiation.

The grain of lake ice has a very different appearance from that of glacier ice, but both are individual crystals. The difference in their appearance is to be traced to the difference of treatment which they have received during their existence. The glacier grains have been practically rolling over each other during their descent, while those of the lake have established themselves at right angles to the surface of the water, and have remained there. So long as the ice is increasing in thickness, the temperature of its upper surface is very low. It is perfectly transparent, and its surface is smooth, dry, and polished like glass, and it shows no trace of crystalline figure. When the ice is undisturbed this develops itself only at the end of the season when the thaw sets in. Then the whole ice-sheet rises to its melting temperature, and is at the same time exposed to the direct radiation of the sun. This produces disarticulation of the ice into groups of vertical prisms which are then floating independently; they are kept together only by crowding. Ice in this state is said to be rotten; and it will be recognised that, however thick the ice-sheet may be, when it gets into this condition it is dangerous. In the neighbourhood of the outflow the crowding is relieved, the disarticulated groups become disengaged, the smaller groups and individual prisms are able to assume their attitude of stability and to float on their sides. All then drift towards the outlet. The ice "breaks up," and the lake is cleared in an astonishingly short time.

If it were not for the law that even impure water in freezing always forms pure ice, the impurity remaining in the liquid and generally entangled in the interstices of the grains, and that the pure ice which is in contact with this impure liquid melts at a lower temperature than that which is in contact with nothing but the water formed by its own melting, the ice-covering of a lake would be a continuous sheet offering no points of weakness, and it would have to melt as a whole. It is doubtful if lakes such as those, met with in the Upper Engadine, would get rid of their ice-covering at all. On the Silser See the ice is usually more than 60 centimetres thick when the thaw sets in, but when once the ice begins to break up the lake is cleared in a day. Sixty centimetres of ice would take a long time to disappear on the basis of surface melting alone.

While the winter lasts, the ice on the lake shows no crystalline structure. This develops only after removal from the water and exposure to the sun. The ice then splits up into prisms in a vertical plane. These are at first of irregular section, and as sun-weathering proceeds the thicker prisms split up into thinner. When a block has lain exposed to the February sun and cold it may fall to pieces, each piece being a long, thin, triangular prism, with some resemblance to a razor-blade. When the ice is cold and dry the outlines of the grains are lines; when the ice has a temperature of 0° C. it melts preferably round the grain, forming troughs in which the water collects,

and the aspect is that of a dark polygon surrounded by light-coloured canals. The columnar grains have their striation like those of the glacier. In one piece, which was much weathered, I counted twenty-four such grains in an area of 9 square centimetres. In a slab which had not been lying long I counted twenty-three grains in an area of 150 square centimetres, giving an average area of 6.5 square centimetres per grain; the largest had an area of 12 square centimetres. In another slab there was a very large grain which measured 7 centimetres in one direction and 4 centimetres at right angles to it. In a slab in which the sun-weathering had proceeded very far I counted 113 grains in a disc of 5 centimetres radius, which gives 0.69 centimetre as the average area per grain.

In the absence of actual experience, one is apt to expect a slab of lake ice, when subjected to sun-weathering, to be disarticulated into hexagonal columns; but this expectation is quite gratuitous. Ice may crystallise in a form bounded by plane faces, according to the laws of its crystallographic system, if it has the freedom which it possesses when crystallising out of an independent medium such as a saline solution or air. But the foreign matter dissolved in fresh water is present in so small quantity that what we have before us is the solidification rather than the crystallisation of ice, and each column as it tries to develop itself is interfered with by its neighbour, and the resulting slab of ice is made up of elementary prisms crowded together, but preserving parallelism of crystallographic axis.

The second part of the discourse dealt with the part played by glaciers and rivers in modifying the features of the surface of the earth, but it cannot be usefully condensed so as to be included in this communication.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE University of Jena, at its recent jubilee, conferred the degree of M.D., *honoris causa*, on Sir William Ramsay, K.C.B., F.R.S.

MR. W. J. HORNE, lecturer in physics at the South African College, Cape Town, has been appointed to the inspectorate of the Transvaal Department of Public Education as organiser for technical education.

UPON the authority of the *Cologne Gazette*, a Reuter correspondent states that the question of the admission of women to university study in Germany has been settled. Women who are subjects of the German Empire will be admitted on the same footing as men, but women of other countries will require the permission of the Minister of Public Instruction for matriculation.

A PAPER on the educational aspect of domestic subjects was read recently by Prof. A. Smithells at Bradford, the occasion being the fourth annual meeting of the Northern Union of Domestic Economy Associations. A verbatim report appears in the first August number of *Education*, and we learn therefrom that Prof. Smithells considers that the increased attention being paid to the teaching of domestic subjects is very gratifying. He wishes to bring such subjects within the purview of universities, as it is desirable to connect every branch of education with what should be the most abundant and vivifying springs of knowledge. The introduction of domestic subjects into the normal educational curriculum for girls would add a much wanted ingredient, as in the household arts we have a direct educational instrument for conferring upon girls the very great gift of manipulative skill, and of doing it by teaching the very work that will lie nearest to them in their normal daily life when they have left school. Domestic subjects include much that affects the cultivation of the moral and æsthetic side of human nature, and a good teacher will make them mentally stimulating.

THE *Revue scientifique* for August 8 reproduces the address given by Prof. Paul Appell, the president of the French Association for the Advancement of Science, at the meeting at Clermont-Ferrand on August 3. As we mentioned in our issue of August 13, the address deals with the teaching of science and the formation of the scientific

spirit, and insists on the necessity of the latter as the foundation for those powers of initiative and of intelligent activity without which progress is impossible. Prof. Appell points out that the object of higher education is three-fold—to make, to teach, and to apply science—and considers in detail how far the educational system of France attains these objects. He finds much overlapping, and directs special attention to the large amount of teaching of pure science which goes on in technical schools the principal function of which, he urges, should be to teach technical applications to pupils already well grounded in science at the universities or other schools of university type. Those interested in higher education in this country will find much food for thought in Prof. Appell's address, and many will ask, Are our institutes for higher education carrying out their duty of making science as they ought? while more will want to know how much of the energy of our polytechnics and technical schools is devoted to teaching pupils the laws of motion or how to solve simple equations.

THE latest article of a series published by the *Times* on American life is devoted to "Colleges and Character." After mentioning the rapid growth of the universities, which in 1904 already had 119,496 undergraduates, the writer agrees with the Rhodes scholar who reported that from the sole standpoint of scholarship it was not necessary for him to leave America. On the other hand, the author of the article lays blame on the "elective" system, which presupposes that the average youth of eighteen, fresh from school, has defined aptitudes, understands himself, has adequately given shape to his ultimate purpose, and can be depended upon to select the studies best adapted to the achievement of his destiny. Nevertheless, he considers that the fundamental idea of electives is sound, but that the reaction from the old rigid courses of instruction has gone too far. A student may graduate by passing in four entirely disconnected subjects in each of four successive years; moreover, there is a temptation to seek "soft options." On the other hand, we may observe that it is commoner in America to find commercial men who, by pursuing the somewhat haphazard sampling of studies which the elective system permits, have acquired intelligent appreciation of, say, comparative religion and Röntgen rays. In England men of the same class rarely attempt any university study. The author expects that "electives" will never be disallowed in the future, but will be intelligently restricted, so as to secure that all students—not merely such as choose—will be subjected to the discipline proper to university life on its intellectual side.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 18.—"An Electrical Method of Counting the Number of α Particles from Radio-active Substances." By Prof. E. **Rutherford**, F.R.S., and Dr. H. **Geiger**.

(1) By employing the principle of magnification of ionisation by collision, the electrical effect due to a single α particle may be increased sufficiently to be readily observed by an ordinary electrometer.

(2) The magnitude of the electrical effect due to an α particle depends upon the voltage employed, and can be varied within wide limits.

(3) This electric method can be employed to count the α particles expelled from all types of active matter which emit α rays.

(4) Using radium C as a source of α rays, the total number of α particles expelled per second from 1 gram of radium have been accurately counted. For radium in equilibrium, this number is 3.4×10^{10} for radium itself and for each of its three α -ray products.

(5) The number of scintillations observed on a properly prepared screen of zinc sulphide is, within the limit of experimental error, equal to the number of α particles falling upon it, as counted by the electric method. It follows from this that each α particle produces a scintillation.

(6) The distribution of the α particles in time is governed by the laws of probability.

The authors have previously pointed out that the principle of magnification of ionisation by collision can be used to extend widely the already delicate methods of detection of radio-active matter. Calculation shows that under good conditions it should be possible by this method to detect a single β particle, and consequently to count directly the number of β particles expelled from radio-active substances.

Further work is in progress on this and other problems that have arisen out of these investigations.

EDINBURGH.

Royal Society, July 13.—Prof. Crum Brown, vice-president, in the chair.—An improved method of esterification: G. E. **Gibson**.—Nitric anhydride as a nitrating agent: G. E. **Gibson**.—The significance of maximum electrolytic conductivity: Prof. John **Gibson**.—The variation of Young's modulus under an electric current, part ii.: Henry **Walker**. In these experiments it was shown that the curious changes in the value of Young's modulus when the iron, steel, copper, or platinum wire was heated by an electric current were not observed when the wire was stretched under a load approaching the limits of elasticity, and that when the wire was heated by ordinary methods no peculiarity in the change of Young's modulus was found to exist.—The theory of general determinants in the historical order of development up to 1860: Dr. Thomas **Muir**.

July 20.—Dr. R. H. Traquair, vice-president, in the chair.—A sensitive state induced in magnetic substances and materials by thermal treatment, part ii.: J. G. **Gray** and A. D. **Ross**. The sensitive state induced by annealing the material from moderately high temperatures was reduced by jarring, but could not be completely obliterated by this means. A strong sensitive state was induced when the material was cooled from room temperature to that of liquid air, or when it was heated from the temperature of liquid air to that of the room; but when the material was cooled to the temperature of liquid air and then heated again, only a small increase was observed in the susceptibility. The effect was associated with temperature change, and was not apparently influenced by the length of time the material was kept at the high or low temperature.—The structure of *Turrilepas peachi* and its allies: F. R. Cowper **Reed**. An examination of type-specimens from Whitehouse Bay and of further material shows that the organism is bilaterally symmetrical. There are four series of plates, a double median longitudinal row of small triangular plates in close contact overlying the larger and more elongated lateral kite-shaped plates. The latter are arranged in pairs on each side, extending (in the middle part of the body) nearly at right angles to the axial line, but becoming inclined more acutely forwards towards the anterior end. The lateral plates also overlap each other for about half their width, and bear on their outer surface a median longitudinal impressed narrow groove which appears as a fold on the reverse side of the plates. The characters of *Turrilepas scotica* were discussed in the light of the newly discovered structure of *T. peachi*, and of fresh material from the Balclutchie beds, and the Scottish species were compared with the undescribed forms from the Ordovician beds of England and Wales, and with the American genera *Strobilepis* and *Lepidocoleus*.—The recalcence of nickel: T. A. **Lindsay**. Two cylinders, one of nickel and one of copper, were allowed to cool simultaneously from a high temperature, the difference of temperature at each instant of time being measured by a thermoelectric couple with the two junctions in the heart of their respective cylinders. The difference curve of cooling so obtained indicated recalcence phenomena at temperatures of 650°C. , 515°C. , and within the range 370°C. to 285°C. —Note on the study of polarisation by means of the Dolezalek electrometer: A. F. **Ewan**. The method afforded a very delicate test of the independence of polarisation on the potential of the electrode, and it was also found possible to extend the time curve of polarisation through a much greater range than had been possible with any one of the other methods. Interesting corroboration was obtained of Bouty's and Wiedeburg's